Radiation Measurements in Soil of Nusirate in the middle of Gaza-Strip Using Nuclear Track Detector CR-39 and Electra Plus

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الملخص

قياس الإشعاع في التربة في منطقة النصيرات وسط غزة باستخدام كاشف المسارات النووية CR-39 وجهاز اليكترا بلص

إن خطورة النشاط الإشعاعي لجسيمات ألفا الناتجة عن غاز الرادون ونواتجه علي صحة الإنسان هو الحافز الرئيسي وراء الدراسات العديدة لقياس التلوث الإشعاعي في البيئة وتشمل التربة ومواد البناء.

تم فحص عينات التربة من وجود جسيمات ألفا باستخدام كاشف المسارات النوويةCR-39 حيث تم تجميع العينات من منطقة النصيرات وسط قطاع غزة .

ألنشاط الإشعاعي لوحدة الحجوم تم إيجاده في عينات التربة المختلفة باستخدام كاشف المسارات النووية لتعين كثافة المسارات النووية الناتجة عن جسيمات ألفا.

النتائج تدل علي أن النشاط الإشعاعي لجسيمات ألفا في التربة كانت أكبر ما يمكن عند 9.305 Bq/ m3 ، وأصغر ما يمكن عند 2.878 Bq/m3 ، والمتوسط عند 5.244 Bq/m3، أيضا النتائج من جهاز اليكترا بلص ستعرض وتقارن بنتائج أخري منشورة.

ABSTRACT

Because of the hazards of radon activity and its daughter products to human health, several studies were conducted to measure radiation in environment including soil and building materials. Alpha particles radiation contents of soil samples were measured using solid state nuclear track detector (SSNTD) CR-39. Soil samples were collected from the middle region of Gaza-Strip, in Nusirate area. Alpha activity per unit volume were evaluated in the sample using solid state nuclear track detector. Results showed that the activity of Alpha particles in soil has a maximum value 9.305 Bq/m^3 , and minimum 2.878 Bq/m^3 , and average is 5.244 Bq/ m^3 . Also results using Electra Plus were discussed and compared with other published data .

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INTRODUCTION:

Alpha particles radiation is the major source of natural radiation in the environment, that is emitted from radioactive decay of colorless, inert gas, Radon (^{222}Rn) . It is a leading cause of cancer that comes only to smoking. Natural radiation is part of the earth's environment that exists in atmosphere, in earth, and in our own bodies. An average person receives a radiation an effective average annual dose of about 300 millirem from natural sources compared to about 50 millirem [1] from artificial sources of radioactive materials such as medical x-ray. Natural radioactive material in rocks and soil account for about 28 millirem or 8% of the radiation dose received by a person in a year from all sources. The earth's crust contains small amount of uranium, thorium and radium as well as radioactive isotopes , including potassium. The radiation dose comes from rocks, soil, and some building materials (such as bricks and concrete). Natural radioactive material are one of most important source of radiation exposure to humans [2]. Although these material contain low-level radioactivity (LLR), the accumulated dose can be high [2]. The most abundant sources of natural background radiation are ^{238}U of life time t= 4.5 billion years, and Thorium ^{232}Th of half life time t =14 billion years in sediment rocks. Both of these elements decay to radon gas but thorium decays to ^{220}Rn that is called thoron with half life time of only 55 second, whereas uranium decays to ^{222}Rn that is called Radon which has half life time of 3.8 days. Because of the difference in half life, radon can diffuse from soil, where it is produced , whereas thoron decays before it reach very far from where it was created [3].

MATERIAL AND METHODS:

Twenty subsurface samples of dry soil were collected from different locations in Nusirate area in the middle region of Gaza Strip , Palestine. Each sample was taken at 1 meter depth below the surface and of one kilogram weight of dry, and clean soil. The radioactivity test has been done using CR-39 which is an allyglycol carbonate plastic that has unique properties of being inert to light, and gamma and beta radiation, but reactive with alpha particles [4]. When alpha particle strikes the plastic's surface it produces a path damage to a depth of approximately 40 nm. The CR-39 method is passive, low cost, long term, most widely used for measuring alpha contamination. Each soil sample was placed in a plastic Jars of 11 cm height and with a cover of 6 cm diameter, the CR-39 detectors were fixed

inside the cover facing the soil sample with very small separation distance less than 1 cm, then the samples were sealed and left for 60 days from November to December of 2004. After that the CR-39 detectors were collected and chemically treated by etching using 6M solution of NaoH at temperature of 70^o C, for 5 hours (standard etching condition). The CR-39 detectors were mounted vertically in stainless steel spring and then immersed in the etching solution inside a water bath of 70^o C. At the end of etching process, the detectors were washed thoroughly with distilled water and then dried. Each detector was counted visually using optical microscope with power of (400), then the average number of track per cm^2, track density of soil, ρ_s , were obtained by taking the average of ten views in the microscope[5].

Methods using Electra Plus monitor:

Electra Plus is a portable rate meter for use with variety of Geiger tube and scintillation probes to measure radiation contamination and radiation dose rate in soil. The Electra Plus consists of an amplifier board, processor and interface board, all housed in painted rectangular section extrusion. The DP6AD scintillation probes is a hand held detector for monitoring of alpha and beta contamination separately or simultaneously. Each soil sample was fitted in a rectangular box made from wood and opened from the upper face, then the scintillation probes was put on the surface of the sample, and the radiation window area is equal to 100 cm^2. The values of alpha and beta activities in soil samples were measured and presented in Figures 7 and 8.

To calibrate the detectors, some of them were exposed to Radium ^{226}Ra source of activity, $\boldsymbol{C_R}$, equal 800 Bq/m^3 for a period of time, T_R, then the detectors collected and treated chemically by etching. The average number of tracks/cm^2 and Track density, $\boldsymbol{\rho}_R$, for the radium source were obtained. These detectors were considered as calibration standard. Then the calibration factor was obtained from the following equation which gives the alpha contamination of soil, C_s, in term of the radium source activity, C_R,

$$C_S\left(\frac{Bq}{m^3}\right) = \left(\frac{C_R T_R}{\rho_R}\right)\left(\frac{\rho_S}{T_S}\right) = K\left(\frac{\rho_s}{T_s}\right) \qquad (1)$$

[8]: where K is the calibration factor, Ts, the exposure time for soil and T_R is the exposure time for radium source. The average value of the calibration factor K was calculated and was equal to = 23.57 ($Bq.\ d\ cm^{2\ )}/(Track.\ m^3$) .

RESULTS AND CONCLUSION:

The alpha activity in soil samples were calculated using equation (2), the calibration factor K as giving above as follows:

$$C_S\left(\frac{Bq}{m^3}\right) = 23.57\left(\frac{\rho_S}{T_S}\right) \qquad (2)$$

where ρ_s is the track density and Ts is the exposure time for soil samples. Results are shown in table (1) which gives the track density for soil and the alpha activity in soil. The results show that the maximum activity of α particles in Nusirate area is 9.304 Bq/m^3, minimum is 2.878 Bq/m^3 and average concentration is 5.244 Bq/m^3 and standard deviation is 2.197 Bq/m^3. Figures 1,2 show the values of tracks /cm^2 vs sample numbers of different sets 1 and 2 of ten samples. Figures 3,4 show the values of alpha concentration activity Bq/m^3 vs sample numbers, where figure 5 shows the average values of alpha concentration , figure 6 shows the maximum , minimum, average and standard deviation. Figure 7 and figure 8 show results of Electra plus monitor for both Alpha and Beta activity.

Table 1: The Results in Nusirate area

Ca Bq/*m*3	C2 Bq/*m*3	T2 Track/*cm*2	C1 Bq/*m*3	T1 Track/*cm*2	Sample no.
3.941	2.772	8.9	5.111	15.1	1
9.304	12.178	39.1	6.4315	19	2
2.878	2.709	8.7	3.047	9	3
6.705	7.350	23.6	6.059	17.9	4
6.694	6.821	21.9	6.567	19.4	5
3.248	2.772	8.9	3.723	11	6
3.475	2.616	8.4	4.333	12.8	7
3.196	2.398	7.7	3.994	11.8	8
5.799	6.385	20.5	5.213	15.4	9
7.196	10.092	32.4	4.298	12.7	10
5.244	5.609	18.01	4.878	14.41	Average
2.197	3.529	11.332	1.198	3.54	STDEV
9.304	12.178	39.1	6.567	19.4	Max
2.878	2.398	7.7	3.046	9	Min

(T1, T2 are soil density for set 1 and set 2 of ten samples, C1, C2, Ca are the alpha concentration activity for set 1 and set 2 and the average)

The results indicated that there are a variation in the values of alpha particles measurements using CR-39 techniques which is due to the type of soil, uranium and radium contents, the rock distribution, and industrial activities. Also the results has been compared with previous values [8, 6, 7], which gives reasonable agreement between them.

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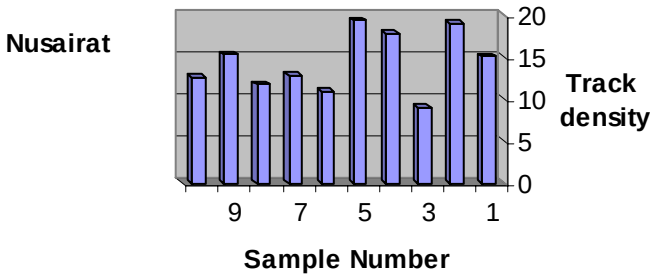
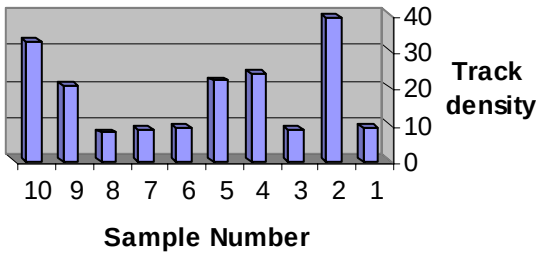
(Set 1)

Figure 1: Track density Vs Sample Number 1



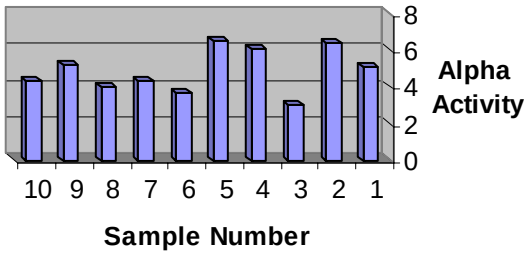
(set 2)

Figure 2:Track density Vs sample Number 2



(set 1)

Figure 3: Alpha Activity Vs Sample number 1



(set 2)

Figure 4: Alpha Activity Vs Sample Number 2

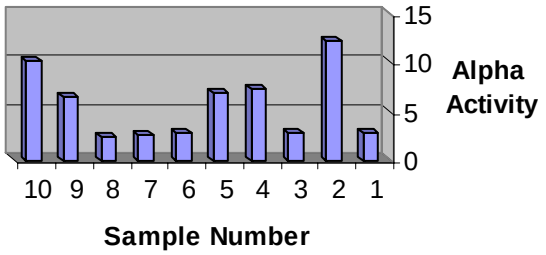


Figure 5: Average Alpha Activity Vs Sample Number

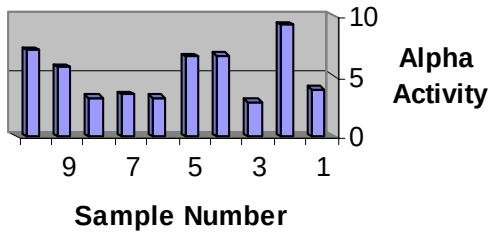
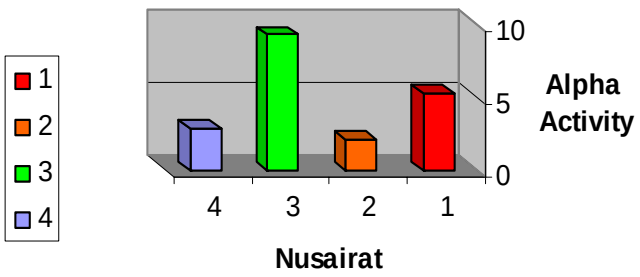


Figure 6: Average, STDEV, Max, MIN



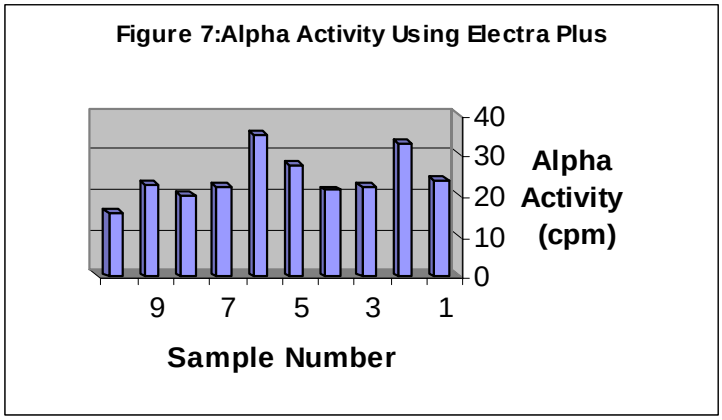


Figure 7:Alpha Activity Using Electra Plus
40
30
20
10
0
Alpha Activity (cpm)
9
7
5
3
1
Sample Number

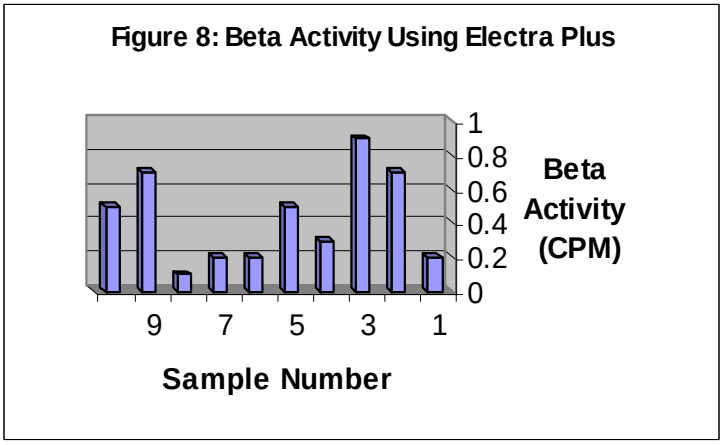


Figure 8: Beta Activity Using Electra Plus
1
0.8
0.6
0.4
0.2
0
Beta Activity (CPM)
9
7
5
3
1
Sample Number